CLAW POLE GENERATOR

Prior Art

The invention relates to a claw pole generator with a rotor, as generically defined by the preamble to the independent claim.

Generators with a rotor of claw pole construction are known for instance from the publication entitled "BOSCH- Technische Unterrichtung, Generatoren" ["Bosch Technical Instruction: "Generators"], 1998-99 edition. The rotor includes first a pole wheel half, connected to a rotor shaft in a manner fixed against relative rotation, and a pole carrier that is connected to the pole wheel half in a manner fixed against relative rotation by means of a retaining means. The retaining means, which is preferably not excitable magnetically, is a continuous ring, which is coaxial with the pivot axis of the rotor and has a generally rectangular cross section. The pole carrier and the pole wheel half, on the inside of the claws toward the pivot axis, each have one approximately cylindrical turned recess, into which the ring is inserted.

The rotor of this known claw pole generator has the disadvantage, among others, that the binding, which can also be embodied as a soldered connection, is made approximately in the middle between the pole carrier and the pole wheel half, by way of an only narrow axial region of the claws. Since the free claw pole ends thus project freely, they can bend open and outward under the load of centrifugal force. A further disadvantage of

the known claw pole generator is that the radially outward-oriented surface of the claw poles of the pole carrier and the pole wheel half is interrupted by the interstices between the individual claws of opposite polarity, which lessens the dissipation of the lost heat.

Advantages of the Invention

With the claw pole generator of the invention, as defined by the characteristics of the independent claim, it is possible to reduce the size of the interstices between the individual claws of opposite polarity. At the same time, the joints of the pole wheel half, retaining means and pole carrier can be reached better from outside the rotor. A connection by material engagement, as was previously attained by hard-soldering the ring to the claw poles, is now possible not only by soldering but by welding, since the intended welding points are easier to reach from outside. Because the joints can be produced by means of a different, it is possible to widen the production tolerances of the components to be joined, which are the pole wheel half, the retaining means and the pole carrier. This reduces the production effort and expense, for instance, and at the same time the production rejection rate.

Another advantage of the at least partial disposition of the retaining means in the claw pole interstices resides in the enlargement of the outer surface area of the rotor, so that heat dissipation is improved substantially. This improvement in lost heat dissipation makes higher generator power possible, so that despite the higher power, limit temperatures for

components are not exceeded.

The claw pole generator of the invention furthermore enables a connection by material engagement in the region of the free claw pole ends as well, so that the bending open of the claws under centrifugal load is reduced. This makes a smaller air gap possible between the outer circumference of the claw poles and the inner circumference of the stator.

By the provisions recited in the dependent claims, advantageous refinements of and improvements to the characteristics recited in the independent claim are obtained.

An advantageous feature of the retaining means is provided by connected two retaining elements, adjoining or bordering on a claw pole, by a so-called tab in the region of a free claw pole end. If these tabs are angled radially inward relative to the rotor shaft axis, the result is a reinforcement of the retaining means, which by its connection with the claw pole additionally reinforces the claw pole tip against widening under centrifugal load. If the retaining means with the bent tab is extended as far as an axial outer side of the pole wheel half, until it is flush with the outer side, the outer side of the rotor is improved as a result, with less fissuring. A further improvement in the retaining means is attained by embodying it as a one-piece body, on which the individual retaining element regions that are located between the various claws are disposed. By means of various reshaping processes, a one-piece retaining means is obtained that has a substantially cylindrical jacketlike structure with open

recesses, alternating on the pole carrier and the pole wheel, for the pole wheel and pole carrier claws, respectively. A reinforcement of the retaining elements can be attained by providing that radially inward-oriented legs extend from the ends adjoining the claw poles in an essentially centrifugal load. This structure is further improved in that two opposed legs in a claw pole interstice are each connected by one web in the region of a respective free first and second claw pole end. If two legs are joined on their radially inward-oriented end by a profile closing element, the result is a closed hollow profile, which is thereby reinforced further. If two adjacent legs of two respective claw pole interstices are connected by a pole end web below the first and second claw poles, then the retaining means is additionally reinforced even further. With the aid of the retaining means of the invention, it is advantageously also possible to use permanent magnets in the interstices between two claw poles of opposite polarity, to reduce the stray flux. In that case, permanent magnets can be secured, for instance to retaining means radially inside the rotor. If the retaining means is embodied, inside the interstices between two claws of opposite polarity, as a hollow profile, then the permanent magnets can be introduced by insertion into this open hollow profile.

Drawings

The invention is described in further detail below in four exemplary embodiments in conjunction with the associated drawings.

Fig. 1 shows a first exemplary embodiment of a

rotor of a claw pole generator of the invention in plan view;

Fig. 2 is fragmentary section taken along the line II- II in Fig. 1;

Fig. 3 shows a side view of a rotor in a second exemplary embodiment;

Fig. 4 shows a sectional view along line IV-IV through the rotor of Fig. 3;

Fig. 5 shows an alternative embodiment for Fig. 4;

Fig. 6 shows a perspective view of a retaining means for the rotor of Fig. 3;

Fig. 7 shows a fragmentary view of a rotor in a third exemplary embodiment;

Fig. 8 is a section through the rotor of Fig. 7 taken along the line VIII-VIII;

Figs. 9 and 10 show a refinement of the rotor of Figs. 7 and 8, in which the two inward-oriented legs are joined together by webs;

Fig. 11 shows a side view through a retaining means of a fourth exemplary embodiment;

Fig. 12 is a fragmentary cross section taken along the line XII-XII of Fig. 11;

Fig. 13 shows the retaining means of the fourth

exemplary embodiment, in which the hollow profile on the side of the pole wheel half is open;

Fig. 14 shows a side view of the retaining means in the fourth exemplary embodiment;

Figs. 15, 16 and 17 show various possible ways of securing permanent magnets to the retaining means; and

Fig. 18, in the upper half, shows a longitudinal section through a known claw pole generator of conducting piece construction, and in the lower half shows a side view of the rotor of that generator.

Identical or identically functioning components are identified by the same reference numerals.

Description of the Exemplary Embodiments

Fig. 18, in the upper half, shows a longitudinal section through a known claw pole generator with a rotor 20 of conducting piece construction. The rotor 20 has a pole wheel half 22, which is connected via a ring 24 to a conducting piece, hereinafter called a pole carrier 26. The mechanical binding between the pole carrier 26, ring 24 and pole wheel half 22 is provided by a respective soldered point between each first claw pole 28 of the pole wheel half 22 and the ring 24, and between each second claw pole 29 of the pole carrier 26 and the ring 24. The rotor 20 is concentrically surrounded by the stator 30.

Fig. 1 shows a first exemplary embodiment of a claw pole generator of the invention. The rotor 20

includes the pole wheel half 22, which is connected to a rotor shaft 32 in a manner fixed against relative rotation. The pole wheel half 22 is in turn connected, also in a manner fixed against relative rotation, by material engagement to the pole carrier 26 by a retaining means 34.

The first claw poles 28 alternate with the second claw poles 29 on the circumference of the rotor 20, spaced apart equally; between the second claw poles 29 and the first claw poles 28, there are claw pole interstices 36. The retaining means 34 of the invention is disposed at least partly in the claw pole interstices.

The first claw poles 28, with claw pole roots 38, merge with a plate 39 of the pole wheel half 22.

The first claw poles 28 and the second claw poles 29 each have approximately radial claw pole flanks 40 on the sides. The retaining means 34 is connected, both on the claw pole flanks 40 of the second claw poles 29 and on the claw pole flanks 40 of the first claw poles 28, by material engagement to both the pole wheel half 22 and the pole carrier 26. A suitable arrangement of the retaining means 34 is provided by having its surface 42 extend substantially on the circumference. The smoothest possible surface of the rotor 20 is obtained if the retaining means, with its radially outward-oriented surface 42, together with the radially outward-oriented faces of the claw poles 28 forms one common cylindrical face, as is also shown in Fig. 1. In this first exemplary embodiment of the rotor 20 of the invention, the retaining means 34 includes a plurality

of individual retaining elements 44, which are each disposed individually in the individual claw pole interstices 36, each between a respective first claw pole 28 and a respective second claw pole 29.

In Fig. 2, the location of the retaining means 34 in which it has the greatest possible spacing from the rotor axis can be seen. With its lateral faces, the retaining means 34 abuts against the claw pole flank 40 of the first claw pole 28 and of the second claw pole 29. At this abutment point, the mechanical binding takes place between the retaining means 34 and the first and second claw poles 28 and 29.

In Fig. 3, a second exemplary embodiment of the rotor 20 with the retaining means 34 is shown. This second exemplary embodiment differs from the first in that adjacent retaining elements 44 are joined together, in the region of a free first claw pole end 46 and a free second claw pole end 47, by tabs 48. These tabs 48 can be seen clearly in Fig. 4, in which the tabs are angled toward the rotor shaft 32. In Fig. 5, a variant of this bent tab 48 is shown, in which the tab 48 located on the side of the pole wheel half 22 ends flush with an axial outer side 50 of the pole wheel half 22. With the aid of this extension as far as the axial outer side 50, interstices between adjacent claw pole roots 38 are also covered, and thus the cylindrical portion of the rotor surface is enlarged. This suppresses a further source of noise.

In Fig. 6, the one-piece retaining means 34 is shown in perspective, as it is provided in the second exemplary embodiment. Here the retaining means 34 is in

one piece, and the tabs 48 integrally join the retaining elements 44. This one-piece retaining means 34 has a substantially cylindrical jacketlike structure, which has open recesses, alternating on the pole carrier and the pole wheel, for the first claw poles 28 and second claw poles 29, respectively.

In Fig. 7, a third exemplary embodiment of the retaining means 34 is shown, in a fragmentary view of the rotor. This third exemplary embodiment is based on the exemplary embodiment shown in Fig. 6. As seen in Fig. 8, radially inward-oriented legs 54 originate at the ends, adjoining the first and second claw poles 28 and 29, of the retaining elements 44. These legs 54 serve to reinforce the retaining means 34, and as a result, if the centrifugal load remains constant, the bending open of the first and second claw poles 28 and 29 is reduced again. A further increase in stability or rigidity is obtained by providing that two opposed legs 54 are joined, in the region a first and a second free claw pole end 46 and 47, by a respective web 56; see Fig. 9. In Fig. 10, the cross-sectional view of this is provided.

In Fig. 11, a fourth exemplary embodiment of the retaining means 34 is shown, in which compared with the third exemplary embodiment of Fig. 6, the legs 54 are joined on their radially inward-oriented ends by a respective so-called profile closing element 60, thus creating a closed hollow profile 61; see also Fig. 12. This fourth exemplary embodiment also has the tabs 48 already known from the second exemplary embodiment, which connect the individual retaining elements 44. As indicated by dashed lines in Fig. 12, the claw poles 28

and 29 may also have claw pole flanks 40' and 40'', respectively, which are not oriented purely radially inward but instead have a tangential component in their orientation as well. Besides these, claw pole flanks 40 that are only partly oriented purely radially inward are also possible, as in Fig. 2. In the fourth exemplary embodiment, the hollow profile 61 is open toward one axial end, while the other axial end is closed; see also Fig. 13. In Fig. 14, a fragmentary side view of the rotor 20 is shown, viewed from the pole wheel half 22 with the retaining means 34, in the form of the fourth exemplary embodiment. This shows that the hollow profile 61, which extends between a first and second claw pole 28 and 29, respectively, is open on the side of the pole wheel half 22. Because the retaining means 34 has a hollow profile 61 that is open toward the pole wheel half 22, the tab 48 accordingly also has two openings. This causes a weakening of the material comprising the tab 48. To compensate for this weakening on this end of the retaining means 34, the tab 48 on its radially inner end has an angled end region 62, which extends between two adjacent claw pole roots 38. A further improvement is obtained by providing that the angle of this tab 48 between two hollow profile openings is reinforced by an end region web 66; see also Fig. 1. To improve the joint connection between the pole wheel half 22, retaining means 34 and pole carrier 26 still further, the tab 48 is connected by material engagement, for instance by a welding point, to the pole wheel half 22 between two claw pole roots 38. A further possibility for reinforcing the retaining means 34 is to connect each two adjacent legs 54 of two claw pole interstices 36 by means of a pole end web 68 below the claw pole ends; see also Fig. 11.

To increase the power of a claw pole generator, permanent magnets 70 are in general provided. These permanent magnets 70 are each placed in the interstices between a respective first and second claw pole 28 and 29. Upon magnetic excitation of the rotor, the polarity of the first claw poles 28 is opposite the polarity of the second claw poles 29. The permanent magnets 70 are oriented such that they counteract a magnetic claw pole field, excited by an exciter coil 72, between two claw poles 28 and 29 of opposite polarity and thus reduce the stray flux. Such permanent magnets 70 can be secured, in the first and second exemplary embodiments, by way of example by adhesive bonding to the underside of the retaining element 44; see Figs. 15 and 16. If the two legs 54 form an undercut, for instance, as in Fig. 17, then it is also possible to introduce the permanent magnets 70 by providing that the hold of the permanent magnet comes about by positive engagement with the two legs 54. In the fourth exemplary embodiment, the permanent magnets 70 can be introduced into the hollow profiles 61 that are open on one end; see Fig. 14. In that case, a fixation of the permanent magnets 70 in the hollow profile 61 can be accomplished by an impregnating resin, which is introduced into the hollow profile 61 between the hollow profile 61 and the permanent magnet 70. To prevent the claw pole generator from being impaired in its function by the retaining means 34, the retaining means 34 must comprise a material that is magnetically ineffective. Particularly for the third and fourth exemplary embodiments, because of the relatively complicated shape, it is an attractive option for the retaining means 34 to be produced in one piece by precision casting of an austenitic material. The cohesion between the retaining means 34, pole wheel half

22 and pole carrier 26 is best achieved by joining these three components by means of welding, soldering or adhesive points. It is contemplated that to produce the welding points, MIG, laser or WIG method is employed.

The four exemplary embodiments described thus far pertain to rotors 20 having a conducting piece or pole carrier 26, in which the pole carrier 26 is secured to the pole wheel half 22 via the retaining means 34. In its embodiment described thus far, the retaining means 34 is also suitable for rotors 20 of claw pole design, which comprise a first pole wheel half 22 and a pole carrier 26, with the pole carrier 26 also embodied as a pole wheel half that is identical to the pole wheel half 22. While in the conducting piece construction a general holding function for the pole carrier 26 of the conducting piece construction is implicit, this is not true for the construction with two pole wheel halves 22. By its fastening to the claw poles 28 or the first claws 36 of the one pole wheel half 22 on the one hand and to the claw poles 28 or first claws 36 of the other, second pole wheel half 22 on the other, the retaining means 34 increases the resistance of the claw poles 28 to bending open, as is already the case with the conducting piece construction. Furthermore, vibration of the claw poles in a direction tangential to the rotor axis is practically prevented. In a rotor 20 having a pole carrier 26 of conducting piece construction, a distinction can be made between the first claw poles 28 and the second claw poles 29, in the sense that the first claw poles 28 have claw pole roots 38, so that a disklike region of one pole wheel half 22 has recesses between the first claw poles 28. In the previous exemplary embodiments, it is in these recesses that the

retaining means 34 is secured in these recesses by tabs, as shown in Fig. 14, or the tab 48 is located in these recesses; see also Fig. 4 and Fig. 5. While this one-sided arrangement is possible only in the rotor 20 having a pole carrier 26 of conducting piece construction, in the case of the rotor 20 with two pole wheel halves 22, it is possible to dispose the tab 48 or secure the retaining means 34 in the recesses of both pole wheel halves 22, since the rotor 20 is constructed essentially mirror-symmetrically.